Initial REE enrichment and evolution in carbonatites: evidence from geochemistry and melt inclusions in Ulgii Khiid carbonatites, Mongolia

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Ulgii Khiid carbonatite is one of the REE-rich carbonatites in Southern Mongolia, which located at the southeastern side of the Gobi-Tien Shan fold belt. The carbonatite mainly composed of medium- to coarse-grained calcite and euhedral-subhedral apatite. Melt inclusions (23~50μm) occur as singly or swarms randomly distributed in the central parts of the apatite crystals, which form fine polycrystalline and contain a complex and varied assemblage of carbonate-silicate solid phases and/or CO_2 bubble. The majority of solid phases present in the melt inclusions are different silicate minerals (e.g. diopside, phlogopite, amphibole), carbonate minerals (e.g. calcite, dolomite), sulfide (e.g. pyrite), oxide (e.g. magnetite), and REE minerals (e.g. monazite, parisite). The association of REE minerals associated with early crystallizing silicates suggests that strong REE enrichment has occurred in the early evolution of the carbonatite magma.

Three immiscible liquid phases (silicate melt, Fe-rich silicate melt, and phosphate melt) coexisted in melt inclusions after heated and quenched. Phosphate melt show much higher REE contents (La_2O_3=0.84~5.09wt.%; Ce_2O_3=2.17~11.91wt.%) than other two melt and their P_2O_5 and Ce_2O_3 are positively correlated, indicating REE are effectively controlled by the amount of the phosphate.

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